CHAPTER 2

NEW TECHNOLOGY TRENDS IN THE TEACHING OF THE ART OF OTOLARYNGOLOGICAL SURGERY

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INTRODUCTION:

In recent years, technology has had a significant impact on surgical education. Virtual reality simulations, 3D printing, and other interactive technologies are now widely used in medical schools and surgical residency programs to enhance conventional surgical training techniques like corpse dissection and viewing surgeries.

Using virtual reality simulations, aspiring surgeons can practice techniques in a realistic but controlled setting. These simulations can be used to teach a variety of medical techniques, including laparoscopic surgery, which entails utilizing specialized devices and small incisions to do surgery. Surgeons can also be trained in intricate or rare operations that they might not frequently encounter in practice using virtual reality simulators.

Anatomy models that can be utilized in surgical education have also been produced using 3D printing. These models can be used to teach in patient care and management as well as to practice surgical methods and procedures. Online instructional tools like video lectures and webinars, as well as telemedicine platforms that enable surgeons to remotely monitor and participate in operations, are further technology utilized in surgical education.

1. Use of Virtual Reality (VR) Simulations

Surgery instruction and training can benefit from virtual reality (VR) simulation. The use of VR simulation enables students to perform surgical procedures in a lifelike setting without endangering actual patients. Additionally, it can be utilized to practice for uncommon or difficult treatments that might not be accessible in a real operating room.

The use of VR simulation in surgical education has several advantages. It first offers a safe, regulated atmosphere where students can practice and make mistakes without suffering repercussions. Second, it gives students the option to practice the steps as often as necessary to advance their knowledge. Thirdly, it gives students opportunities to engage with a variety

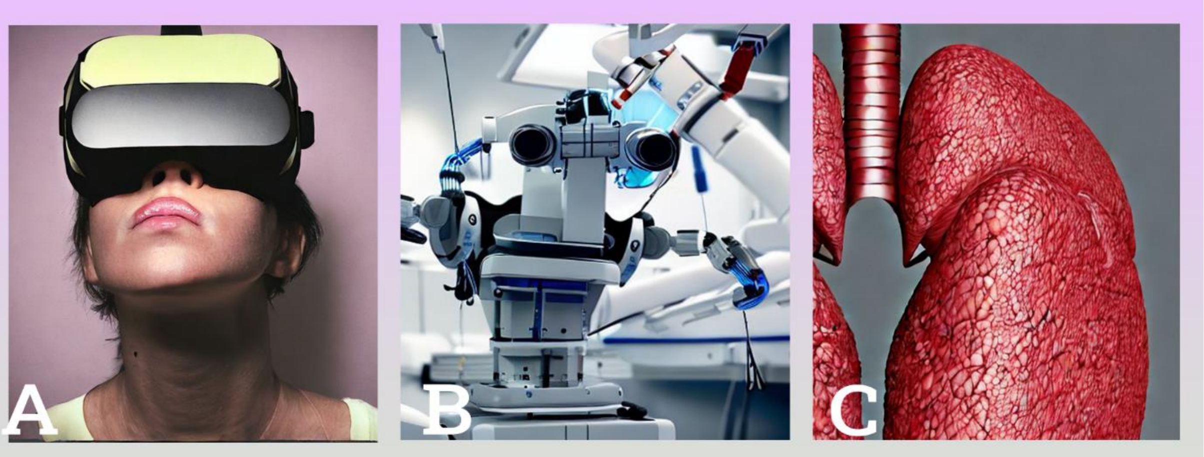

Fig1. *Modern surgical pedagogy using new technologies like A. Virtual reality (VR) simulation, B. Surgical robots, C. 3D printed Anatomy models like this- 3D printed human lung. Images in public domain.*

of issues and situations that they might not meet in a real operating room. Additionally, since there is no longer a need for actual cadavers or training animals, it enables students to practice in a more effective and economical manner.

The use of VR simulation in surgical education could have some drawbacks as well. It might not accurately recreate the complexity and unpredictability of a real surgical environment, which is one of its limitations. It might not offer as much tactile feedback as using genuine tissue and equipment, which is another drawback. Finally, it might not be as good at teaching non-technical skills that are equally crucial in the operating room, such teamwork and communication.

Overall, virtual reality (VR) simulation can be a helpful tool for surgical education and training, but it should be combined with other training techniques including hands-on practice with cadavers or animals and watching or helping with actual procedures (Alaker et al., 2016).

2. Using Surgical Robots to learn Surgery

Operating rooms are increasingly using surgical robots, commonly referred to as robotic-assisted surgical systems. They are made to help surgeons carry out intricate surgeries more precisely and accurately. To give surgical students, the opportunity to practice surgical methods and procedures in a simulated setting, some surgical robots are also employed in teaching and training.

Using surgical robots to teach surgery has several advantages. One advantage is that, in comparison to conventional approaches, such as cadavers or animals, they can offer a more accurate simulation of surgical procedures. Operating rooms are increasingly using surgical robots, commonly referred to as robotic-assisted surgical systems. They are made to help surgeons carry out intricate surgeries more precisely and accurately. To give surgical students, the opportunity to practice surgical methods and procedures in a simulated setting, some surgical robots are also employed in teaching and training.

Using surgical robots to teach surgery has several advantages. One advantage is that, in comparison to conventional approaches, such as cadavers or animals, they can offer a more accurate simulation of surgical procedures. The regulated and constant training environment that surgical robots may offer can be beneficial for students to hone their skills. Furthermore, the utilization of surgical robots can be made to practice for intricate or uncommon treatments that might not be accessible in a real operating room.

The use of surgical robots in teaching surgery may also have certain drawbacks. They might not accurately imitate the complexity and unpredictability of a real surgical environment, which is one drawback. They might not offer as much tactile feedback as using genuine tissue and equipment, which is another drawback. Finally, they might not be as effective at teaching non-technical skills that are equally crucial in the operating room, such teamwork and communication. In summary, surgical robots can be an effective teaching and training tool, but they should be utilized in addition to other training techniques including hands-on training with cadavers or animals and watching or helping with actual surgeries (Soliman & Tammany, 2021).

3. Training and Educational use of 3D printing

Using successive layers of material, 3D printing, commonly referred to as additive manufacturing, creates actual objects from computer models. By enabling the production of specialized surgical instruments and implants, 3D printing technology has the potential to transform a variety of industries, including medicine. As a training and educational tool, 3D printing can also be applied to the teaching of surgery. To help students grasp anatomy and practice surgical skills, 3D printed models of organs or other body parts might be employed. Realistic simulations of surgical procedures can be made using 3D printed models, which can be useful for students to practice and hone their skills.

The use of 3D printing in the training of surgeons has a few advantages. The ability for students to practice on realistic, anatomically correct replicas that closely resemble real tissue and organs is one advantage. Compared to more conventional techniques, such using cadavers or animals, this can simulate surgical procedures more accurately. Additionally, 3D printing can be used to create specialized models that can be catered to a trainee's unique educational requirements.

The use of 3D printing in the training of surgeons may also have certain drawbacks. One drawback is that the complexity and unpredictability of a real surgical setting may not be accurately reflected in 3D printed models. They might not offer as much tactile feedback as using genuine tissue and equipment, which is another drawback (Eigl et al., 2020).

4. Telemedicine for teaching surgery

Surgical procedures can be streamed live via telemedicine platforms, allowing students and trainees to see and learn from the procedure in real time. Students who are unable to physically attend the surgery may find this to be of particular benefit. Interactive case discussions can be facilitated through telemedicine systems, where students can ask questions and receive advice from skilled surgeons. For students, it can be a useful learning experience to see how skilled surgeons address various patients (Belakovskiy et al., 2022).

Platforms for telemedicine can be utilized in a variety of ways to teach surgery, for example, Telemedicine can be utilized in the following settings to teach young surgeons:

1. Use telemedicine platforms to stream live surgeries or procedures so that students or trainees can watch and learn in real-time.

2. Telemedicine systems can be utilized to offer virtual surgery simulations, giving trainees the opportunity to hone their surgical abilities in a simulated setting. This allows you to perform virtual surgeries or procedures without risking real human lives.

3. Mentor and guide students remotely: Telemedicine platforms can link students with skilled surgeons especially those in the big cities of India like Mumbai, who can serve as mentors and role models for residents in remote, rural, mountainous, and difficult to access areas like the hilly areas of Konkan. This can facilitate case-based learning by using telemedicine platforms, which enable students to study and discuss various surgical cases with their classmates and mentors situated in another corner of India.

4. Provide online lectures and seminars: Telemedicine platforms can be utilized to present online lectures and seminars on surgical themes, enabling students to gain knowledge from top-surgeons in the field.

5. The capacity to deliver real-time, interactive learning experiences and access to a wealth of instructional resources are just a couple of the advantages that telemedicine platforms offer for teaching surgery.

5. Teaching residents with as Virtual Endoscopy

A medical imaging approach known as virtual endoscopy visualizes and examines the hollow organs and tissues inside the body using computer-generated, three-dimensional (3D) pictures. It is a simple, painless procedure that does not involve anaesthesia or inserting an endoscope into the body. To produce accurate, 3D models of the inside of the body, it instead uses imaging techniques like computed tomography (CT) scans and magnetic resonance imaging (MRI). The doctor may examine the organs and tissues in detail by rotating and seeing them from various angles using these models.

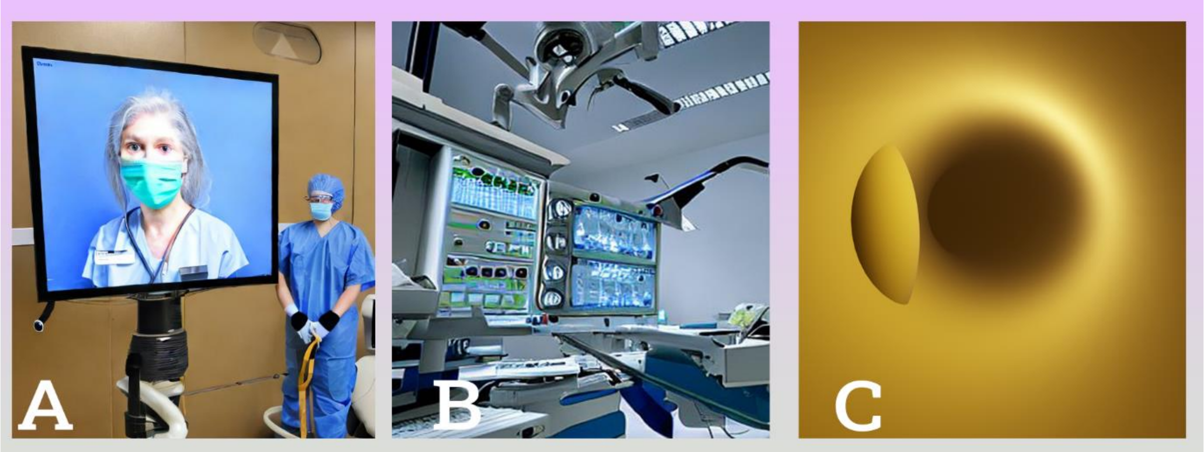

Fig2. *Modern surgical pedagogy using new technologies like A. A Surgical Telemedicine Conference, B. Surgical Navigation System, and C. Virtual endoscopy of organ showing submucosal flat lesion on stimulation (Images A and B in public domain CC0, C author's own clinical archive CC BY 2.0 attribute to first author "Santhosh Kumar Rajamani")*

Virtual endoscopy software and simulations come in a variety of forms and can be utilized on a range of gadgets, including computers, tablets, and smartphones. To aid students in understanding the theories and methods used in endoscopic procedures, certain virtual endoscopy software applications also incorporate educational tools and interactive learning materials, including as quizzes, films, and case studies.

With the use of computer-generated, three-dimensional images, doctors can view the interior of a patient's body using the medical imaging technology known as virtual endoscopy. It can be used to instruct students by giving them a practical, hands-on learning experience that enables them to practice and learn about endoscopic operations without having to encounter actual patients. Although, it might not be appropriate for all individuals or circumstances, virtual endoscopy is usually regarded by experts as a secure and reliable diagnostic tool.

Students can learn about the interior organs and systems of the body, as well as the methods and abilities necessary for carrying out endoscopic procedures, using virtual endoscopy. It can be particularly helpful for instructing students who are pursuing careers as doctors, nurses, or other healthcare professionals because it can give them invaluable practical experience in a secure setting.

Virtual endoscopy is frequently utilized to identify and assess problems including cancer, ulcers, and other abnormalities in the digestive system, lungs, and other organs. Virtual endoscopy can diagnose problems like stricture of bronchus, growths of colon, ulcers, polyps and other abnormalities in the digestive system, lungs, and other hollow organs. In addition, Surgical planning, and the course of minimally invasive treatments like biopsies or laparoscopies, bronchoscopies can also be done using it.

Virtual endoscopy is not meant to take the place of actual conventional endoscopy and other procedures for training and experience of residents. It is meant to complement and improve conventional techniques. To ensure that medical professionals have the information and skills required to give the greatest care to their patients, the most effective training will ultimately combine virtual and real-world experiences, as well as continual education and practice (Hashimoto et al., 2018).

6. Teaching residents using surgical navigation system

A surgical navigation system is a computer-assisted instrument that assists surgeons in precisely and accurately guiding their surgical tools. It makes use of several technologies, including ultrasound, magnetic resonance imaging (MRI), and computed tomography (CT), to provide precise, three-dimensional images of the patient's body and the surgery site. Example use cases are in FESS and Operations involving the Skull base or Clivus.

Surgical navigation systems can be used to teach students about surgery by giving students a hands-on, interactive learning experience that allows them to practice, acquire skills and learn about surgical procedures without having to risk actual patient lives. Students can practice their abilities in a secure and controlled setting by using a surgical navigation system, which can be especially helpful for individuals who are pursuing careers as surgeons or other healthcare professionals (Zhang et al., 2019).

Conclusion

In recent years, technology has had a big impact on surgical procedures. With application of technology in surgical settings helps to enhance patient outcomes, lower the chance of problems, and boost the effectiveness and efficiency of surgical procedures Technology is being used in a variety of ways to improve the pedagogy of Otolaryngologic Surgery, including:

Minimal Access Surgery: Advancements in imaging technology and laparoscopic instruments, many surgical procedures can now be carried out with small incisions and specialized equipment. Patients who undergo this kind of surgery may have less discomfort and recover more quickly than conventional open operations. Typical examples are FESS versus Radical maxillary antrostomy or Laparoscopic Cholecystectomy versus open Cholecystectomy.

Robotics: Robotic aid is currently used in several surgical procedures. These devices can help surgeons carry out intricate surgeries with more control and accuracy while lowering the possibility of problems.

3D printing: This technology allows to produce tailored implants, surgical tools, and patient anatomy models for use in pre-op planning and training.

Virtual Reality: Surgeons use this technology to plan and carry out surgery in real-time as well as practice and train for complex procedures without the resultant risk to human lives.

Telemedicine: Technology is also being utilized in telemedicine to link doctors and patients at a distance, enabling remote consultations and occasionally even remote operations. Overall, the application of technology in surgical settings helps to enhance patient outcomes, lower the chance of problems, and boost the effectiveness and efficiency of surgical procedures.

Virtual Endoscopy: This is a useful diagnostic and teaching tool that visualizes and examines the hollow organs and tissues inside the body using computer-generated, three-dimensional (3D) pictures. Computer uses computed tomography (CT) scans and magnetic resonance imaging (MRI) images to create a 3Dimensional virtual stimulation of the organ, which can be used to teach residents, plan, and implement surgical procedures.

Surgical navigation system: This is a computer-assisted instrument that assists surgeons in precisely and accurately guiding their surgical tools using data provided by computed tomography (CT) scans and magnetic resonance imaging (MRI) images. Example use cases are in FESS and Operations involving the Skull base or Clivus. Surgical navigation systems can be used to teach students about surgery by giving students a hands-on, interactive learning experience that allows them to practice, acquire skills and learn about surgical procedures without having to risk actual patient lives.

References

1. Alaker, M., Wynn, G. R., & Arulampalam, T. (2016). Virtual reality training in laparoscopic surgery: A systematic review & meta-analysis. International Journal of Surgery (London, England), 29, 85–94. https://doi.org/10.1016/j.ijsu.2016.03.034
2. Belakovskiy, A., Jones, E. K., Murphy, C. N., Kelley, S., Gallagher, K., Furst, W., Furgal, A., & Heidelbaugh, J. (2022). Socially Distanced Teaching: Faculty Feedback on Teaching During Telemedicine. Medical Science Educator, 32(6), 1305–1307. https://doi.org/10.1007/s40670-022-01685-9
3. Eigl, B., Haslebacher, C., Muller, P. C., Andreou, A., Gloor, B., & Peterhans, M. (2020). A Multimodal Pancreas Phantom for Computer-Assisted Surgery Training. IEEE Open Journal of Engineering in Medicine and Biology, 1, 166–173. https://doi.org/10.1109/OJEMB.2020.2999786
4. Hashimoto, D. A., Petrusa, E., Phitayakorn, R., Valle, C., Casey, B., & Gee, D. (2018). A proficiency-based virtual reality endoscopy curriculum improves performance on the fundamentals of endoscopic surgery examination. Surgical Endoscopy, 32(3), 1397–1404. https://doi.org/10.1007/s00464-017-5821-5
5. Kye, B., Han, N., Kim, E., Park, Y., & Jo, S. (2021a). Educational applications of metaverse: Possibilities and limitations. Journal of Educational Evaluation for Health Professions, 18, 32. https://doi.org/10.3352/jeehp.2021.18.32
6. Soliman, M. K., & Tammany, A. J. (2021). Teaching and Training Surgeons in Robotic Colorectal Surgery. Clinics in Colon and Rectal Surgery, 34(5), 280–285. https://doi.org/10.1055/s-0041-1729861
7. Zhang, F., Zhu, X., Gao, J., Wu, B., Liu, P., Shao, P., Xu, M., Pawlik, T. M., Martin, E. W., & Xu, R. X. (2019). Coaxial projective imaging system for surgical navigation and telementoring. Journal of Biomedical Optics, 24(10), 1–9. https://doi.org/10.1117/1.JBO.24.10.105002